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ABSTRACT

Rosaceous shrubs are an important component of the vast shrublands of the Intermountain area. They provide forage and cover for animals, esthetic beauty for man, and are of value as soil stabilizers. The general vegetative, floral, reproductive, hybridization, distribution and habitat, and use characteristics are described and reviewed for Amelanchier alnifolia, A. utahensis, Cercocarpus intricatus, C. ledifolius, C. montanus, Cowania mexicana var. stansburiana, Fallugia paradoxa, Peraphyllum ramosissimum, Purshia glandulosa, P. tridentata, and Rosa woodsii. Artificial hybridization studies demonstrate the fundamental genetic compatibility in the Purshia-Cowania-Fallugia group. A taxonomic key covering each taxon discussed is provided.

INTRODUCTION

Shrubs dominate much of the vegetation in the Western United States and form characteristic types from the lowest deserts to the tops of the mountains (Plummer 1974). There are approximately 325 million hectares (700 million acres) of shrubland over this broad area. In Utah, shrubby plants dominate or characterize approximately 75 percent of the vegetation (McArthur and others 1974). Most shrubs are palatable and are important components of the forage consumed by big game and livestock on the western ranges. In addition, some shrubs are useful for stabilizing and beautifying roadcuts, mine spoils, and other raw, exposed soils, as well as for landscaping residential, commercial, and recreational areas.

Some of the most important browse and ornamental shrubs belong to the rose (Rosaceae) family. Ecotypes within species exhibit immense variation. Some rosaceous shrubs in association with micro-organisms can fix nitrogen (Webster and others 1967; Hoeppel and Wollum 1971; Krebill and Muir 1974). This is a particularly valuable trait in nitrogen-deficient soils common on western wildlands. Natural hybridization of species of the same genus and even between genera is fairly common. Therefore, we believe by careful selection and artificial hybridization these shrubs can be improved for a variety of purposes, but particularly for increased browse on big game ranges and for cover on disturbed areas such as roadcuts and mine spoils.

The purpose of this paper is to document what is presently known about some important browse shrubs of the rose family in the Intermountain area with regard to their vegetative and flowering characteristics, hybridization, distribution, and use. Most of the observational information and experimental data was gathered from the Intermountain area (Holmgren and Reveal 1966), especially from Utah. Holmgren and Reveal's Intermountain area includes all of Utah, that portion of Arizona north of the Grand Canyon, most of Nevada, parts of California that lie within the Great Basin, the sagebrush areas of southeastern Oregon, southern Idaho to the high mountainous areas to the north, and the red desert area of southwestern Wyoming. However, comment and reference to species distribution and attributes outside this area are made when pertinent. We believe this will be helpful in formulating the basis for genetic improvement of these shrubs for specific needs.

Each species, its hybridization, distribution, and use are described in detail. Each genus and its included species are arranged in alphabetical order. A key for the included genera and species is given (appendix).

METHODS

A survey of literature, particularly of pertinent keys and monographs, was conducted before hybridization experiments began. In addition, some observations of floral and vegetative characteristics were made during 1967 and later growing seasons. Collections were made of shrubs in various stages of development for illustrative purposes. Artificial hybridization was tried between *Cowania mexicana* var. *stansburiana*, *Purshia tridentata*, *Fallugia paradoxa*, and the *Cowania-Purshia* hybrid by treating emasculated flowers of each with pollen from the others (fig. 1). Flowers which were to receive pollen or to serve as controls were covered with white paper bags before anthesis (fig. 1). These artificial crosses were made to determine if there are any major difficulties in interspecific hybridization within and between these closely related genera.

Figure 1.--Cliffrose (Cowania mexicana *var.* stansburiana) *with flowers emasculated, bagged, and pollinated with antelope bitterbrush* (Purshia tridentata) *and Apache plume* (Fallugia paradoxa) *pollen.*

Figure 2.--Germinated seeds of antelope bitterbrush.

Viability of the seed produced from the controlled pollinations was determined by placing evenly distributed seed on moistened newspapers or paper towels, which were then folded in half. The folded papers were covered by plastic sheets and placed in refrigerators at temperatures maintained between 1° and 4° C for 6 months. This temperature treatment is adequate to break seed dormancy of most rosaceous shrubs (fig. 2).

Seedlings from sprouted seeds were transplanted to pint or quart milk cartons and placed in greenhouses to develop (fig. 3). The milk cartons had holes punched in their bases to allow drainage. Plants were watered when the soil was dry.

Seedlings of the various crosses that had been obtained since 1968 were transplanted late in May 1971, to range adaptation plots just south of Manti, Utah.

Figure 3.--An antelope bitterbrush X Stansbury cliffrose hybrid seedling produced by artificial hybridization.

SPECIES CHARACTERISTICS

Amelanchier alnifolia (Saskatoon serviceberry)

Saskatoon serviceberry is an erect deciduous shrub 1 to 4.5 m tall (fig. 4), with gray bark on older stems and smooth, reddish-brown bark on younger stems.

The leaves are simple, alternate, and usually borne on short, lateral branchlets. They are up to 5 cm long and 2.5 cm wide, with serrate margins above the middle, and are usually glabrous at maturity, although this quality varies somewhat between ecotypes.

The showy, white, epigynous flowers are borne in short, erect racemes. They contain persistent sepals, five deciduous, oblanceolate petals about 12 mm long, numerous stamens, and a single pistil usually with five styles.

Figure 4.--Saskatoon serviceberry growing near Kamas, Utah. Picture taken in early October 1967 after leaves had dropped and fruits had dried. Note dried fruits on uppermost branches. Scale is in feet.

Figure 5.--Saskatoon serviceberry branch showing leaves and nearly mature fruit.

The edible glabrous fruit is a bluish or purplish globe-shaped pome 5 to 9 mm in diameter (fig. 5). It is five-celled. Each cell contains one or two seeds. Saskatoon serviceberry averages 45,395 cleaned seeds per pound (100/g) (Plummer and others 1968).

Considerable variation is present in the shape, size, amount of pubescence, and serrations on leaf margins (fig. 6). Seed size is also highly variable.

Flowers bloom during May and June and fruits ripen during July and August. Numerous blossoms occur almost every year, but because of frost and juniper rust (*Gymnosporangium*) infestations, good seed crops may only be produced every 3 to 5 years.

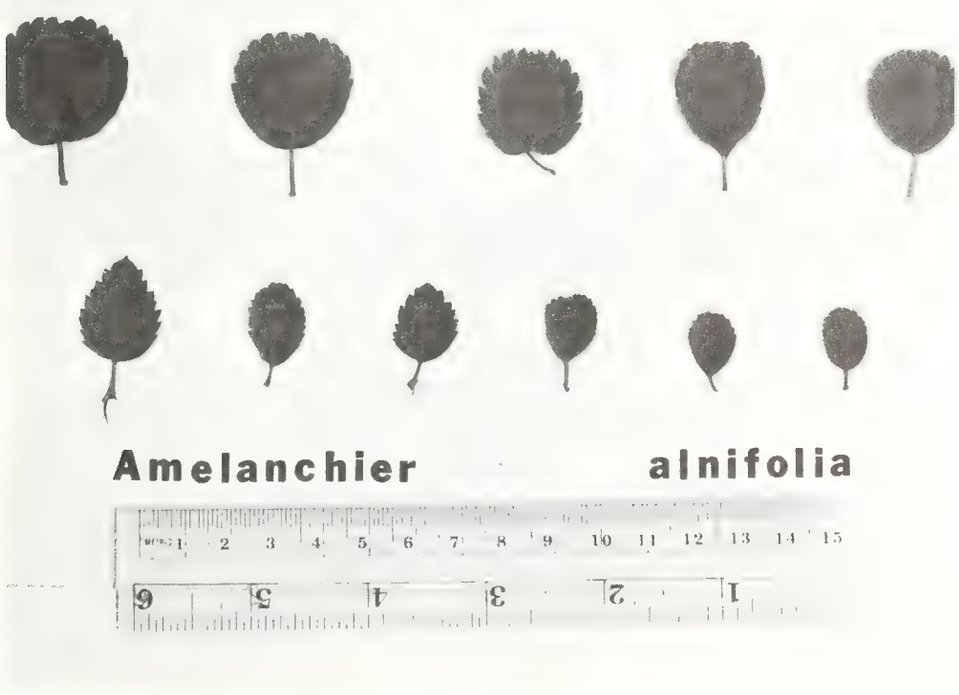

Figure 6.--Variation in Saskatoon serviceberry leaves. The leaves are from three different bushes representing three accessions.

Hybridization: There are wide differences in ecotypes of Saskatoon serviceberry. Some have proven much more resistant to juniper rust than others. No doubt resistance to disease and other desired characteristics can be improved through intraspecific and interspecific hybridization. *Amelanchier* is noted for its intergradation between species (Jones 1946; Hitchcock and others 1961; Cruise 1964).

Observations to date indicate that stigmas mature before anthers. Thus, artificial hybridization by mass pollination should be possible without having to emasculate flowers, particularly if they prove to be self-incompatible.

Distribution and Habitat: Saskatoon serviceberry grows under a variety of environmental conditions. It is a fairly important shrub throughout the juniper-pinyon type and is sometimes common in big sagebrush lowlands. This species is most prolific in relatively moist, sloping habitats in openings within or just below the ponderosa pine (*Pinus ponderosa*) type. Its range extends from California eastward throughout the Rocky Mountains to Nebraska and Michigan and as far north as Alaska.

Use: Serviceberry is a valuable browse plant due to its fair-to-high palatability and ready availability to livestock and big game. It is browsed by cattle after midsummer when the more palatable grasses and forbs have been grazed or have dried up. Big game show varying preference for this shrub. They use it chiefly in the fall and winter. The fleshy fruits (pomes) are sought by a wide variety of birds and mammals. Some people harvest them for jams and jellies.

Amelanchier utahensis (Utah serviceberry)

Utah serviceberry is a shrub 0.5 to 5 m tall (fig. 7), with numerous branched, pubescent, ash-gray twigs.

Figure 7.--A Utah serviceberry bush near Canaan Mountain, Washington County, Utah.

The leaves are 1 to 3 cm long, somewhat leathery at maturity, and usually permanently pubescent, with soft, crisp, often yellowish hairs, particularly on the lower surface.

Flowers consist of 5 sepals, which are reflexed and persistent, five white petals, 5 to 10 mm long, numerous stamens, and usually two or three styles. The ovary is inferior, or nearly so, with false partitions forming twice as many cells as there are styles. The flowers bloom during May and June and fruits mature in the fall.

The pomaceous fruit is finely pubescent and green when young, changing at maturity to a yellow or golden color, not juicy, and 6 to 7 mm broad. Fruits often dry and harden on the bushes and may persist for as long as 2 years or until removed by small mammals or birds. Utah serviceberry averages 25,800 cleaned seeds per pound (57/g) (Plummer and others 1968).

Hybridization: Davis (1952) and some other authors relegate this species to a subspecies of *Amelanchier alnifolia*. We believe with Jones (1946) that specific status is warranted by its different fruiting and growth habits. Putative hybrids between these two species have been noted, particularly where they occur together. Improvement of various desired characteristics by selection and artificial hybridization between Utah and Saskatoon serviceberry should be possible. Cruise (1964) showed that gene exchange is common in *Amelanchier* species in eastern North America.

Distribution and Habitat: Utah serviceberry occurs in Colorado, Utah, Nevada, California, Arizona, and New Mexico. It grows in foothills from 610 to 2,590 m (2,000 to 7,000 feet) on dry, rocky slopes (fig. 7), and is associated with a wide range of shrubs and trees, including sagebrush (*Artemisia* spp.) pinyon pines (*Pinus edulis* and *P. monophylla*), ponderosa pine, and aspen (*Populus tremuloides*). This species is most common in southwestern Utah and southeastern Nevada. It is generally found on drier sites than Saskatoon serviceberry. Where they occur together, Saskatoon serviceberry is found in the more mesic swales and Utah serviceberry on the outer ridges.

Use: Utah serviceberry provides good forage for cattle and good to excellent browse for sheep and goats, principally in early spring because it leafs out and blooms earlier than most associated shrubs. Deer browse the shrub throughout the year, but are most dependent on it during winter. Persistence of dried fruits on the bushes aids the survival of birds and small mammals through critical periods in the winter and spring.

Cercocarpus — Common Floral Characteristics

This genus has small, inconspicuous perigynous flowers which occur solitarily or in axillary or terminal groups. The flowers have five deciduous sepals attached to the rim of the hypanthium, numerous stamens inserted in two to three rows on the hypanthium, and one pistil. Petals are lacking. Although flowers are quite similar in all species of mahogany, curlleaf (*C. ledifolius*) tends to have the largest flowers, littleleaf (*C. intricatus*) the next largest, and true mountain mahogany (*C. montanus*) the smallest. The achene terminates in elongated, hairy, persistent, variously curved or twisted styles or plumes (fig. 8 and 16).

Figure 8.--Mountain mahogany branch comparison. Left to right: Cercocarpus intricatus, C. ledifolius, C. ledifolius X C. montanus *hybrid*, C. montanus.

Cercocarpus intricatus (Littleleaf mountain mahogany)

Littleleaf mountain mahogany is a small, intricately branched shrub to 2.5 m tall (fig. 9), with narrowly linear and strongly revolute leaves (fig. 8), usually less than 12 mm long. *Cercocarpus intricatus* averages 50,910 cleaned seeds per pound (112/g) (Plummer and others 1968).

Hybridization: Cercocarpus intricatus hybridizes with both *C. ledifolius* and *C. montanus*. Stutz (1974) suggests that *C. intricatus* is a dry, harsh site segregant of *C. ledifolius*.

Figure 9.--Littleleaf mountain mahogany heavily hedged on foothills east of Ephraim, Sanpete County, Utah.

Figure 10.--Littleleaf mountain mahogany associated with black sagebrush (Artemisia nova) on Wah-Wah Mountains, Beaver County, Utah.

Distribution and habitat: Littleleaf mountain mahogany occurs on harsh sites which are exposed to high temperatures and drought (fig. 10). It is restricted almost entirely to Utah, Nevada, and northern Arizona; however, there is a similar low-growing form in Washington and Oregon called *C. ledifolius* var. *intercedens* (Hitchcock and others 1961).

Use: Like all mountain mahogany species, *C. intricatus* is a fine browse plant. It is an excellent winter feed for deer.

Cercocarpus ledifolius (Curlleaf mountain mahogany)

Curlleaf mountain mahogany is an erect shrub or sometimes a small tree to 7 m tall (fig. 11).

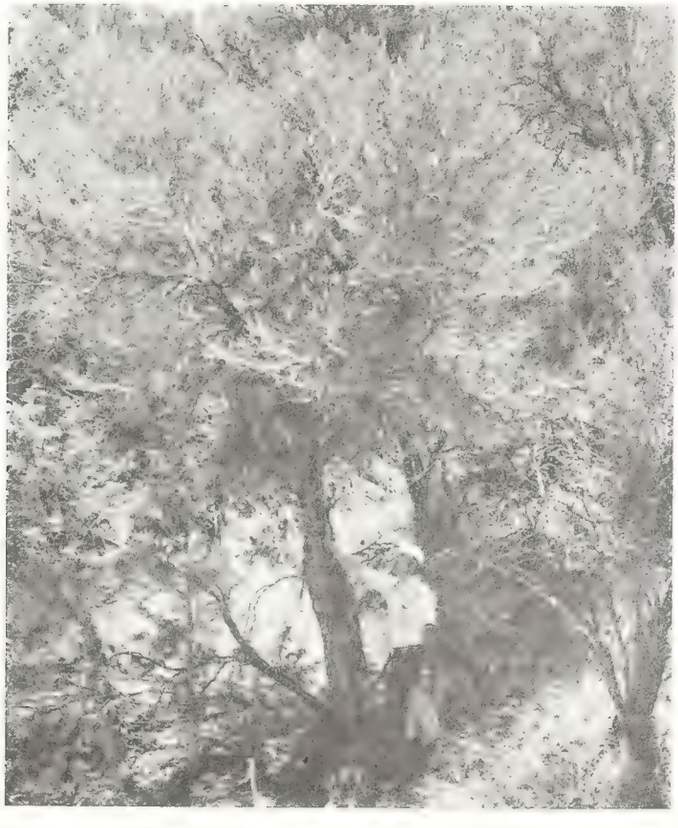

Figure 11.--Curlleaf mountain mahogany near Wasatch Pass, Sevier County, Utah.

Figure 12.--Mountain mahogany leaf comparison. Upper left, Cercocarpus intricatus; *lower left,* C. ledifolius, *center, hybrids; right,* C. montanus.

The leathery, evergreen leaves are elliptic to lanceolate, 12 to 25 mm long, and less than 12 mm wide. They are somewhat resinous and glabrous above, white hairy beneath, with entire revolute margins, and a prominent midrib.

The plumose style on the fruit is 50 to 75 mm long. The flowering period extends from May to June, and fruit ripens from May to August. Curlleaf mountain mahogany averages 51,865 cleaned seeds per pound (114/g) (Plummer and others 1968).

Hybridization: Natural hybrids (fig. 12 and 13) between true mountain mahogany (*C. montanus*) and littleleaf mountain mahogany have been observed in most places where their respective ranges overlap.

Figure 13.--Natural hybrid between curlleaf mountain mahogany and true mountain mahogany.

Stutz (1974) suggests that highly plastic *C. ledifolius* is ancestral to *C. montanus* and *C. intricatus*. He believes *C. montanus* may have evolved to fit its present more mesic habitat by gradual broadening and enlargement of its leaves and development of its deciduous habit. He also theorizes that *Cercocarpus intricatus* evolved to fit a more xeric habitat by developing smaller, narrower leaves, which it retains even when growing in more moist riparian conditions.

The chromosome number of curlleaf mountain mahogany is $2n = 16$ (Pyrah 1964).

Distribution and Habitat: Curlleaf mountain mahogany occurs at elevations between 1,830 and 2,740 m (6,000 and 9,000 feet) in Utah on dry, rocky ridges usually on southern or western slopes. Occasionally, it can be found in coarse soil on steep northern slopes and among cliffs (fig. 14). Its range extends from Montana to Washington, south to Colorado, northern Arizona, and California.

Use: Curlleaf mountain mahogany is excellent winter game browse. In contrast to true mountain mahogany, it is not fire tolerant, which may explain its absence on many areas where it has occurred and would otherwise grow. This is likely the reason it is often confined to rocky and severe sites that are not susceptible to burning because of lack of fuel. Fire tolerance could be bred into it from *C. montanus*. Unfortunately, because of the arborescent habit of this species, the bulk of the foliage in mature stands is out of the reach of grazing animals (fig. 11); stands are often highlined as high as the animals can reach. Thompson (1970) found that available browse in *C. ledifolius* in the Manti-LaSal National Forest in central Utah could be increased considerably if tops were pruned from April 20 to May 10 and from September 10 to 30. Topping during other periods resulted in complete mortality. He reported that top-pruned trees often produced to 200 percent more growth than unpruned trees. He therefore suggested that this method could be used as a means of increasing available browse on selected sites of big game winter ranges. Wood of curlleaf mountain mahogany has a high density and burns slowly. It is prized as a barbecue fuel.

Figure 14.--Curlleaf mountain mahogany growing on and below granite ridges, Mineral Mountains, Beaver County, Utah.

Cercocarpus ledifolius X *C. montanus* hybrid

These hybrids are more erect and somewhat taller than the true mountain mahogany growing in the same area. Their stature is more akin to that of curlleaf mountain mahogany (fig. 11 and 13).

The leaves of the hybrid are highly variable. In some instances, they resemble curlleaf mountain mahogany and in other true mountain mahogany. While the persistence of leaves on hybrid shrubs is more characteristic of curlleaf mountain mahogany than true mountain mahogany, there is considerable variation of leaf persistence between individual native hybrid plants. The hybrid is usually 2 to 4 weeks later in flower development than true mountain mahogany. In this respect it is more like curlleaf mountain mahogany.

Hybridization: These plants are products of hybridization. They hybridize with both parental species to form first and later generation backcrosses.

Distribution and habitat: These hybrids occur in many places where the two parental species are or have been contiguous. This has been particularly noted in Utah. Like *C. montanus*, the hybrid apparently has some fire tolerance since it occurs on fire scars where *C. ledifolius* is no longer present.

Use: The *C. ledifolius* X *C. montanus* hybrid is an excellent browse. However, because of its large stature, substantial portions of its twigs and foliage are unavailable to browsing animals.

Cercocarpus montanus (True mountain mahogany)

True mountain mahogany is a shrub to 4 m in height or rarely a small tree to 6 m in height (fig. 15). Leaves are deciduous, short-petioled, to 5 cm long and 2.5 cm wide, and flat, with dentate margins (fig. 8 and 12). The plumose style (fig. 16) on the fruit measures to 10 cm in length. Depending on elevation, the flowering period varies from mid-May to late June, and fruit ripens from late July to mid-September. This species is highly fire tolerant and resprouts vigorously on burns.

Figure 15.--True mountain mahogany.

Figure 16.--True mountain mahogany showing a typical twisted plumose achene (near center).

The slowing effect of elevation on flower and fruit development is well demonstrated by this species. On June 18, 1967, at an elevation of 2,380 m (7,800 feet), true mountain mahogany was in late flower. Only 2 days later, at an elevation of 1,830 m (6,000 feet), it was in late fruit. True mountain mahogany averages 59,030 cleaned seeds per pound (130/g) (Plummer and others 1968).

There is a wide variation in ecotypes both geographically and by elevation. Leaf size and shape are variable (fig. 12). A number of small-leafed true mountain mahogany shrubs occur west of Richfield, Utah, on the lower foothills of the Pahvant Range. These appear to be a distinctly different ecotype than those growing elsewhere.

The chromosome number of true mountain mahogany is $2n = 16$ (Pyrah 1964).

Hybridization: Our observations indicate that the stigmas of true mountain mahogany mature before the stamens. Consequently, we believe artificial hybridization by mass pollination would be possible when the flowers first open.

Natural hybridization between the deciduous *C. montanus* and the evergreen species *C. ledifolius* and *C. intricatus* occurs at many places in Utah where their ranges overlap (fig. 13). Plummer and others (1957) reported that the more vigorous semievergreen hybrids of *C. montanus* X *C. ledifolius* are relatively common in Utah, particularly along the west slopes of the Wasatch Plateau and the Wasatch Mountains. Pyrah (1964) observed that hybrids of *C. ledifolius* X *C. intricatus* are common because their flowering periods overlapped. He found that hybrids of *C. montanus* X *C. ledifolius* are less common because of a 2-week flowering period difference between the parental species. Hybridization between *C. montanus* and *C. intricatus* was reported to be rare (Pyrah 1964). Development of strains useful for a variety of purposes, particularly range restoration, should be possible by selection and artificial hybridization. Mountain mahogany species and hybrids can often be distinguished by leaf characteristics (fig. 12).

Figure 17.--True mountain mahogany growing on herb-depleted south-facing slope in Miller Canyon southeast of Nephi, Juab County, Utah.

Distribution and Habitat: True mountain mahogany occurs from 1,220 to 3,040 m (4,000 to 10,000 feet) over a wide range of habitats from the Rocky Mountains westward with eastward extensions into South Dakota and Montana. It often grows in coarse, shallow soil on south- or west-facing slopes and ridges (fig. 17), but is also common in the more moist, fertile, deeper soils of canyon bottoms and on north slopes at lower elevations (fig. 18).

This species is frequently associated with gambel oak (*Quercus gambelii*), Utah juniper (*Juniperus osteosperma*), pinyon pines, ponderosa pine, serviceberry, bitterbrush (*Purshia tridentata*), manzanita (*Arctostaphylos* spp.), buckbrush (*Ceanothus* spp.), species of rabbitbrush (*Chrysothamnus*), and species of sagebrush. *Cercocarpus montanus* is often the dominant species of the association and frequently occurs in nearly pure stands.

Figure 18.--True mountain mahogany growing with Utah juniper on a north-facing slope in Salina Canyon, Sevier County, Utah.

A similar but taller species, birchleaf mountain mahogany (*C. betuloides*), which occurs quite commonly in the Sierra Nevada Mountains, retains its leaves in the winter. The extent to which it hybridizes with true mountain mahogany is not known, but we believe they would cross readily.

Use: True mountain mahogany is grazed by all classes of grazing animals in the summer and winter and is one of the more valuable winter browse plants of deer.

Cowania mexicana var. *stansburiana* (Stansbury cliffrose or cliffrose)

Stansbury cliffrose is a much-branched evergreen, shrubby or arborescent plant, 1 to 6 m tall (fig. 19), and is often resinous and strong smelling. The stems are erect, rather stiff, and have gray, shreddy bark.

Leaves are clustered along the branchlets and are 12 to 25 mm long, with revolute margins and a five- to seven-toothed apex. They are light-to-dark green, glandular, dotted above, and more or less white tomentose beneath.

The fragrant, showy flowers are bisexual or rarely staminate (McMinn 1951). They are solitary, on short branchlets, and approximately 20 mm broad. Flowers are perigynous with five persistent sepals and five cream or sulphur-yellow petals. The numerous stamens occur in two series, enveloping 5 to 12 hairy pistils (fig. 20). The fruits are achenes, each about 3 mm long and tailed by a plumose style 25 to 50 mm long (fig. 21, 26, 35).

Flowers bloom from May to June and fruits ripen from July to August. There are often two blooming periods, one in June and another in August. The second blooming is usually dependent on summer storms. The best seed results from the first blooming period, although some seed may be produced in September and October from the later blooms.

Figure 19.--Large Stansbury cliffrose growing north of Mona, Juab County, Utah.

Figure 20.--Stansbury cliffrose flower: left, *in full bloom;* right, *developing achenes.*

Figure 21.--Stansbury cliffrose flower showing developing achene. Note the long feathery styles.

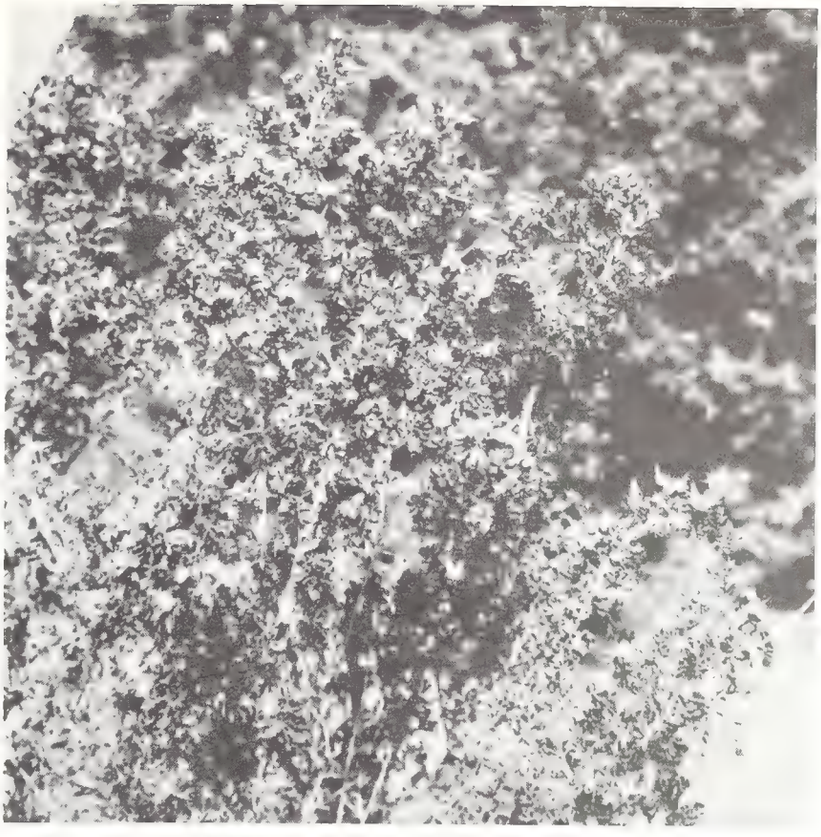

Figure 22.--Achenes developing on a natural hybrid between antelope bitterbrush and cliffrose.

Flowers in all stages of bloom were studied at different locations to determine which matured first, stigmas or stamens. No definite conclusion was reached. Both organs may mature about the same time. Soon after the flower opens, the stigma appears to be receptive and some of the outer stamens are starting to dehisce.

Seeds are tightly held in the achene and are separated only by intense rubbing, whereas, seeds of cliffrose relatives, antelope and desert bitterbrush (*Purshia glandulosa*) readily separate from their achenes. Stansbury cliffrose averages 64,615 cleaned seeds per pound (142/g) (Plummer and others 1968).

Cliffrose has a chromosome number of $n = 9$ (Stebbins 1959).

Hybridization: Natural hybrids of Stansbury cliffrose crossed with antelope bitterbrush (fig. 22) or desert bitterbrush are fairly common where the ranges of these species overlap.

A small population of putative Stansbury cliffrose-Apache plume hybrids occurs along Ranger Pass about 12 miles west of the Big Springs Ranger Station, Kaibab National Forest, Arizona (fig. 23). Both parents also occur in this vicinity. This population contains the only known natural hybrids between these two species. On July 25, 1968, 72 seeds were collected from these hybrids and 16 (22.2 percent) germinated. Only two of these seedlings grew into young plants.

Artificial hybridization performed by treating emasculated flowers of Stansbury cliffrose (fig 24) with pollen from Apache plume, antelope bitterbrush, and the cliffrose-bitterbrush hybrid has produced viable seed and seedlings (table 1).

Viable seeds have also been obtained by artificially pollinating emasculated flowers of bitterbrush, the bitterbrush-cliffrose hybrid, and pistillate flowers of Apache plume with Stansbury cliffrose pollen (table 1).

Figure 23.--A putative natural hybrid between Stansbury cliffrose and Apache plume in the Kaibab National Forest, Coconino County, Arizona.

Stansbury cliffrose is essentially self-incompatible. This characteristic was determined by bagging branches of cliffrose which had flowers still in bud and also branches on which all buds were emasculated. No pollen was added to the sacks. The emasculated flowers produced no viable seed. The nonemasculated flowers produced only 10 viable seeds (1968-71). Three of these were produced by a branch on which the paper sack had been punctured, possibly allowing extraneous pollen to enter. The other seeds, however, were produced on branches covered by intact sacks. These nonemasculated control flowers bore 500 seeds, of which 10 germinated for a percentage of 2.0, compared to 3.3 percent for Stansbury cliffrose crossed with Apache plume and 53.9 percent for Stansbury cliffrose crossed with antelope bitterbrush (table 1).

Figure 24.--A Stansbury cliffrose flowerbud in proper stage of development for emasculation.

Table 1.--*Seed and seedlings obtained from artificial hybridization between Stansbury cliffrose (Comes), antelope bitterbrush (Putr), cliffrose-bitterbrush hybrid (Hybrid), and Apache plume (Fapa)*[1]

Maternal (seed) plant	Paternal (pollen) plant	No. of seeds collected 1967-1971	No. of seeds germinated	Percent germination 1967-1971	Percent germination Low	Percent germination High	No. of seedlings alive 8/28/72
Comes	Fapa	[2]1,418	47	3.3	0.0	4.2	7
Comes	Putr	[3]1,544	832	53.9	.0	63.5	97
Comes	Hybrid	[4]592	396	66.9	29.4	80.0	28
Putr	Fapa	[5]19	19	100.0	--	--	7
Putr	Comes	606	491	81.0	71.7	92.5	103
Putr	Hybrid	185	171	92.4	91.4	94.1	31
Fapa	Comes	[7]3,647	[6]19	.52	.0	14.3	0
Fapa	Putr	[7]1,899	10	.53	--	--	0
Fapa	Hybrid	[7]1,735+	0	.0	--	--	0
Hybrid	Fapa	[8]18	18	100.0	--	--	2
Hybrid	Comes	369	251	68.0	22.5	100.0	15
Hybrid	Putr	249	225	90.4	48.1	100.0	41

[1] Species symbols obtained from Plummer and others (1966).

[2] In 1971, 784 seeds from this cross were collected. Only 37 of these seeds were plump and obviously filled; 33 (89.2%) of these plump seeds germinated.

[3] In 1971, 562 seeds from this cross were collected; 362 of these seeds were plump, the rest appeared shriveled. The plump seeds showed a germination percentage of 91.6, whereas surprisingly, 5.5% of the shriveled seeds germinated.

[4] In 1971, 240 of 295 seeds collected from this cross were plump and 236 (97.2%) of the plump seeds germinated.

[5] Only obviously filled seeds counted. Cross made during only 1971.

[6] In 1968, 19 of 133 seeds (14.4%) collected from this cross germinated.

[7] Cross made only during 1970.

[8] Cross made only during 1971.

These results suggest that emasculation is not necessary and that mass pollination of cliffrose flowers just as they begin to open may be sufficient for hybridization. However, the progeny from such crosses should be carefully inspected to identify the ones that may occasionally develop from self-fertilization.

Distribution and Habitat: Stansbury cliffrose is commonly found on dry, rocky foothills and mesas and frequently is associated with pinyon and juniper trees. It is sometimes found at the lower fringes of the ponderosa pine zone at elevations from 1,220 to 2,440 m (4,000 to 8,000 feet) in favorable sites in the big sagebrush (*Artemisia tridentata*), blackbrush, (*Coleogyne ramosissima*), and salt desert shrub types. The distribution of Stansbury cliffrose ranges from southern Colorado to Nevada, Utah, Arizona, southern California, and northern Mexico (Kearney and Peebles 1960). The northernmost population of cliffrose is found in Cache County, Utah. This shrub has

been observed to establish and grow well from plantings in southern Idaho and eastern Washington; but, after 20 years, it is showing some mortality in Idaho. While good seeds have been produced from these plantings, no natural reproduction has been seen.

Use: Stansbury cliffrose is a highly important winter browse plant for cattle, sheep, and deer. Generally, it is not as palatable as bitterbrush; but on some winter ranges, it is more palatable than bitterbrush--probably because of its more evergreen habit. In southern Arizona, Stansbury cliffrose is not palatable. Accessions from this area have a different two-dimensional chromatogram of phenolic compounds than palatable populations from northern Arizona and central Utah (E. D. McArthur and R. Stevens, 1972. Chromatography information on file at Intermountain Forest and Range Experiment Station, Ephraim, Utah).

Fallugia paradoxa (Apache plume)

Apache plume is a much-branched, often evergreen shrub, 1 to 2 m tall (fig. 25). Leaves are borne in clusters along branchlets. They are pinnately divided into three to seven linear lobes with revolute margins.

The large, white, showy, solitary, perigynous flowers, 25 to 38 mm broad, are usually borne at the ends of slender, elongated peduncles. The typical flower has five sepals that alternate with five supplementary bractlets giving the appearance of 10 sepals, five free-spreading white petals, numerous stamens inserted in three series on the margin of the hypanthium, and numerous pistils.

The numerous short, hairy achenes, 3 mm or less long, produced by this species are tailed by long, reddish plumose persistent styles 25 to 38 mm long (fig. 26). The styles turn white when the seed matures. Apache plume averages approximately 420,000 cleaned seeds per pound (925/g)(U.S. Forest Service 1948).

Figure 25.--Pistillate flowers of Apache plume showing near mature achenes. Note the bagged branch on the left used in hybridization studies.

Figure 26.--Comparison of fruiting branches of the Apache plume--cliffrose-bitterbrush complex. Left to right: Apache plume, Stansbury cliffrose, Stansbury cliffrose X antelope bitterbrush hybrid, antelope bitterbrush.

McMinn (1951) reported that the flowers are bisexual or rarely staminate. However, we have found populations in which the shrubs were mostly monoecious or dioecious. At a site in North Willow Creek Canyon, northwest of Richfield, Utah, at an elevation of 1,680 m (5,500 feet), a number of shrubs were examined June 23, 1967, preliminary to a hybridization attempt with some associated cliffrose shrubs. Although all the flowers on the Apache plume were perfect, in that both pistils and stamens were present, some shrubs bore flowers in which the stamens were well developed but the pistils rudimentary and nonfunctional (fig. 27). Other shrubs bore flowers in which the pistils were well developed, but the stamens were rudimentary and nonfunctional (fig. 28). Finally, a majority appeared to be monoecious, bearing both pistillate and staminate flowers. Whether a flower was pistillate or staminate was obvious even in the bud stage when the enclosing petals and sepals were removed. Only a few fully bisexual flowers were found among the Apache plume plants at this locality.

A population of *F. paradoxa* with only perfect and staminate flowers occurs west of Bryce Canyon National Park, Garfield County, Utah, in Red Canyon on the edge of a ponderosa pine type.

The flowering period of Apache plume varies from area to area depending on such factors as elevation and moisture. McMinn (1951) reports floral development from April to June in California, Kearney and Peebles (1960) from April to October in Arizona, and the USDA Forest Service Woody Plant Seed Manual (1948) from June to August. In

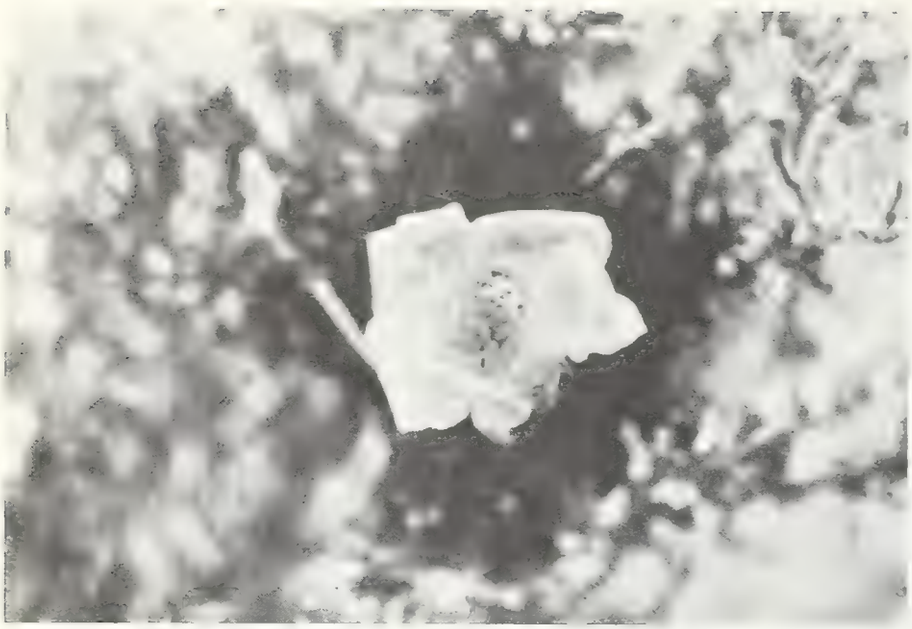

Figure 27.--A staminate Apache plume flower.

Utah, some blooming continues from June to October or until time of frost. There is usually a heavy first blooming that produces more than 90 percent of the annual seed crop. Heavy summer storms can stimulate additional blooming resulting in considerable seed production. However, we have never observed a later seed crop as productive as that of the first blooming.

Ants, hornets, and bees have been observed on Apache plume flowers. We suspect these insects are important factors in the cross-pollination of Apache plume.

Hybridization: During the years 1967-70, some of the pistillate flowers on shrubs located at North Willow Creek Canyon, about 2 miles northwest of Richfield, Sevier

Figure 28.--Pistillate flowers of Apache plume in various stages of development.

County, Utah, were bagged while still in bud to see if they produced any viable seed without pollen being added to the bags. Over 1,200 seeds were produced, but only 5 (0.4 percent) germinated. These viable seeds may have been produced parthenogenetically or the flowers may have produced sufficient pollen to pollinate the pistils. Evidence of self-compatibility was obtained in 1968 when a monoecious branch was bagged as a control. It produced 155 seeds of which 31 (20 percent) germinated.

Artificial hybridization attempted by treating pistillate flowers of Apache plume with pollen from cliffrose and antelope bitterbrush (fig. 25) has produced only a few viable seeds and seedlings (table 1). We believe the production of viable seed from these crosses can be improved. Since so few viable seeds were produced using Apache plume as the maternal plant, it was used in 1971 as the pollen source for hybridization of emasculated flowers of bitterbrush, cliffrose, and the cliffrose-bitterbrush hybrid. Better seed production was obtained (table 1). A few putative natural hybrids between this species and cliffrose have been observed in the Kaibab National Forest in Arizona. These hybrids have the Apache plume characteristic of vigorous underground spread, a trait that would be useful in cliffrose and bitterbrush. Certainly, they would be less vulnerable to fire.

Distribution and Habitat: Apache plume occurs in southern California, Nevada, southern and central Utah, Arizona, New Mexico, western Texas, and northern Mexico. It grows best in such deep, moist, rich sites as open canyon bottoms and the sides of arroyos. It occurs, however, in a variety of soils from dry, rocky ridges of the lower brush types through the pinyon-juniper type to the open ponderosa pine belt. Apache plume is most abundant in the southern parts of its range. The northernmost population in Utah was thought to be the one north of Richfield, Sevier County, Utah, in the Willow Creek area; however, in the spring of 1971, a single small Apache plume was found growing about 30 miles further north in the foothills west of Gunnison, Sanpete County, Utah. Apache plume has established well from planting east of Boise, Idaho. Through introduction, this shrub's range could be greatly expanded.

Use: Apache plume is low to fair in palatability. It is important winter forage in the southeastern portion of its range. Apache plume is also an important erosion-control plant in the arid regions where it grows. It is useful for this purpose because it spreads underground vegetatively. Nursery stock and wildings have been planted for erosion control. Where seed sources exist, it spreads naturally to roadside shoulders and barrow pits.

Apache plume is highly fire tolerant. Clumps have been observed to sprout back vigorously after campfires have been built on them. If this strong attribute could be bred into Stansbury cliffrose and antelope bitterbrush, their value for erosion control would be greatly improved.

Peraphyllum ramosissimum (Squawapple)

Squawapple is an intricately-branched shrub to 2 m tall, with deciduous, simple, nearly sessile leaves clustered at the ends of short branchlets (fig. 29). The leaf blades are 12 to 50 mm long and 5 to 9 mm wide. They are light green, glabrous above and paler with minute pubescence below.

The pale-pink, fragrant epigynous flowers are borne solitarily or in clusters of two or three. Flowers are composed of five persistent reflexed sepals, five spreading petals about 8 to 12 mm long, about 20 stamens, and one pistil.

The flowering period of squawapple is from April to July, depending on ecotype, elevation, and climate. The fruit is a small, yellowish, globose, bitter pome about 12 mm or less in diameter at maturity. Squawapple averages 23,750 cleaned seeds per pound (52/g) (Plummer and others 1968).

Figure 29.--Squawapple with maturing fruit.

Hybridization: Stigmas of young flowers are exserted and appear ready to receive pollen before the anthers of the receptive flowers are open. Mass pollination of bagged flowers just as they begin to bloom may therefore be sufficient for hybridization, particularly if the flowers are self-incompatible. Other species with which squawapple hybridizes naturally are not presently known.

Distribution and Habitat: Squawapple ranges from Oregon to Colorado and California. The largest populations occur in Utah where it is often an important constituent of the mountain brush. It is found at altitudes from 1,220 to 2,590 m (4,000 to 8,500 feet).

Use: Fruits of squawapple are readily eaten by small mammals, particularly chipmunks and field mice. Birds, deer, and livestock show considerable preference for the apples when they are available. The new twigs and foliage are readily eaten by big game and livestock which may browse on the shrubs in the winter, although other plant species may be preferred (Davis 1952; McKean 1956). Because of durability on severe sites, this shrub might provide valuable rootstocks on which to graft closely related shrubs that are more sensitive to environmental extremes.

Purshia glandulosa (Desert bitterbrush)

Desert bitterbrush in Utah is usually a dense, upright shrub similar in appearance to Stansbury cliffrose and is often mistaken for it (fig. 30). At higher elevations in California and Nevada, prostrate forms are encountered (Nord 1965). The species has been regarded as a stabilized hybrid between antelope bitterbrush and cliffrose (Thomas 1957; Stebbins 1959; Stutz and Thomas 1964; Stutz 1974). The evergreen leaves are dark green, nearly hairless, and dotted with impressed glands on the inrolled edges. Leaves are cleft into 3-5 linear lobes.

The yellow to sometimes cream-colored flowers are showy and about 20 mm broad on second-year or older growth. Each flower has five persistent petals, about 25 stamens, and usually two or three pistils.

The persistent receptacle is downy haired or woolly, resinous, and dotted below. Fruits are oblong achenes protruding from the receptacle. Usually three, but sometimes two, fruits are produced. The fully developed fruit is 5 to 20 mm long, hard and leathery, and slightly grooved, tapering to a beak that is a vestigial plume in some

Figure 30.--Desert bitterbrush surrounded by blackbrush near Motoqua, Washington County, Utah.

instances. The seed has a smaller diameter-to-length ratio and is redder than antelope-bitterbrush. Desert bitterbrush averages 20,800 cleaned seeds per pound (46/g) (Plummer and others 1968).

In Utah, flowers bloom in May with the fruit ripening by mid-July at lower elevations and by mid-August at higher elevations. Blooming and seed maturity occur earlier on more southerly ranges. However, in California, blooming has been observed as late as August at elevations of 2,740 m (9,000 feet).

Hybridization: Natural hybrids between desert bitterbrush and antelope bitterbrush or Stansbury cliffrose are common in areas where the species occur together. Stebbins (1959) reports that desert and antelope bitterbrush form such extensive hybrid swarms in eastern California where their ranges overlap that identity of their parental types is completely obliterated.

Purshia glandulosa has $n = 9$ chromosomes (H.C. Stutz, Professor of Botany and Range Science, Brigham Young University, Provo, Utah, personal communication).

Distribution and Habitat: Desert bitterbrush is found in southern Nevada, southern California, northwestern Arizona, and southwestern Utah. It normally occurs on drier sites than antelope bitterbrush; however, there are major zones of overlap. At lower elevations in southwestern Utah, desert bitterbrush is associated with blackbrush and Stansbury cliffrose and at higher elevations, with big sagebrush, antelope bitterbrush, and Saskatoon serviceberry.

Use: Desert bitterbrush is an important browse plant throughout its range. It is usually less palatable than antelope bitterbrush, but more palatable than Stansbury cliffrose (Sampson and Jespersen 1963).

Desert bitterbrush readily sprouts following burning. Shoots are formed from deeply embedded roots, which make desert bitterbrush particularly valuable in stabilizing roadcuts and similar surfaces where several feet of topsoil have been removed (fig. 31). This shrub is especially recommended for restoration of mine spoil areas and other seriously disturbed sites because of its sprouting characteristics and ability to grow in soils of low fertility. Ecotypes with a wide range of adaptation are being sought for use in the revegetation of widely scattered disturbed areas.

Figure 31.--Desert bitterbrush growing on a raw roadcut east of Independence, Inyo County, California. These plants sprouted from roots exposed by road construction.

Purshia tridentata (Antelope bitterbrush)

Antelope bitterbrush is an intricately branched shrub varying in stature from low prostrate forms (fig. 32) to erect arborescent forms as tall as 4.6 m (fig. 33). The branches of prostrate forms often root when in contact with the ground (fig. 34). This layering characteristic is common in prostrate bitterbrush throughout much of its range. It is a common understory shrub in ponderosa pine and lodgepole pine (*Pinus contorta*) types. In general, layering forms show much greater tolerance to fire than do upright nonlayering forms. Fire tolerance in bitterbrush is a valuable trait.

The yellow flowers are perigynous, perfect, showy, about 8 mm broad, and usually solitary on short, lateral branchlets. Each flower has five persistent sepals, five pale-yellow, spreading petals, about 25 stamens inserted on the hypanthium in one series, and one or occasionally two pistils (fig. 35).

The leathery, oblong, pubescent achene is about 5 to 12 mm long and is tipped by a persistent tapering style (fig. 35).

Figure 32.--Prostrate form of antelope bitterbrush common over much of the West, particularly in the mountain brush and the ponderosa pine zones.

Figure 33.--Giant arborescent form of antelope bitterbrush growing northeast of Mt. Pleasant, Sanpete County, Utah. This population has obviously received introgression from cliffrose.

Figure 34.--Antelope bitterbrush showing adventitious rooting along ground level.

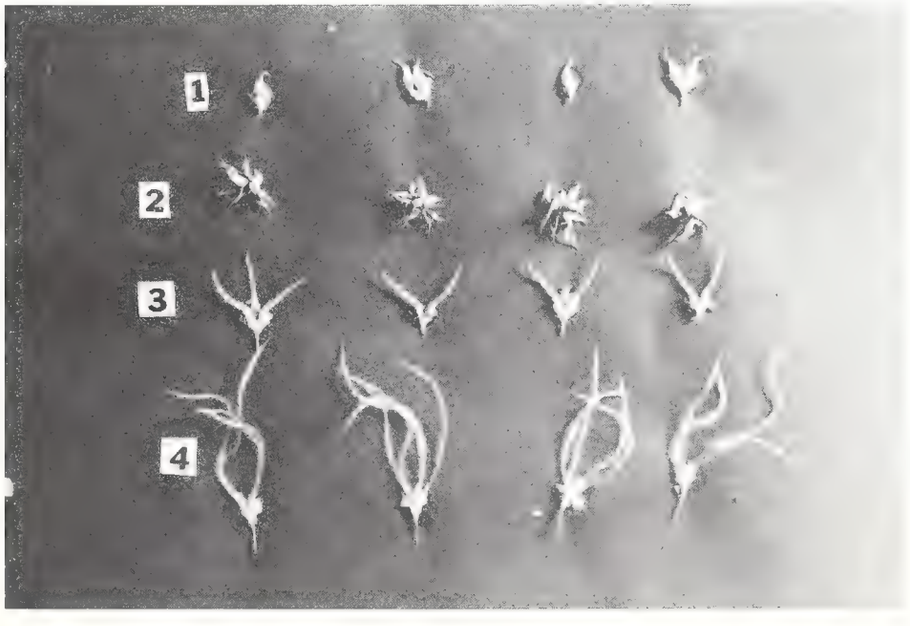

Figure 35.--Comparison of achenes of the bitterbrush-cliffrose complex: (1) typical bitterbrush receptacles with one or two achenes; (2) crowded bitterbrush receptacles with five to seven achenes; (3) typical bitterbrush X cliffrose hybrid receptacles each with two or three achenes with short plumes; (4) typical cliffrose receptacles each with four or five plumed achenes.

Flowers bloom from April to July and fruits ripen from July to September. The effect of elevation on the rate of flower and fruit development of most shrubs is well illustrated by the following examples. Bitterbrush was in early fruit June 18, 1967, at Pigeon Hollow in Sanpete County, Utah, 1,520 m (5,000 feet); it was in all stages of flowering at Oaks Climatic Station in Ephraim Canyon, Utah, 2,380 m (7,800 feet); and it was still in bud at Snowberry in Ephraim Canyon, 2,560 m (8,400 feet).

Study of floral phenology indicated that the stigmas and stamens reach maturity about the same time. A variety of bees and wasps frequent the blossoms, and ants, aphids, and cicadas have also been found. Evidently, insects are important in the pollination of the flowers in nature. Cicadas, however, may do considerable damage in high population years. Wounds are made on twigs and branches by the ovipositor when the eggs are deposited. Bitterbrush populations suffer occasional damage from tent caterpillars. Antelope bitterbrush averages 15,400 cleaned seeds per pound (34/g) (Plummer and others 1968).

Hybridization: Antelope bitterbrush crossed with cliffrose or desert bitterbrush produces fertile hybrids in nature (fig. 22 and 26). Hybridization between antelope bitterbrush and cliffrose is very common throughout Utah where their ranges overlap. Also, many F_2 and backcross segregants are common. Careful examination reveals cliffrose traits in most populations of bitterbrush in the region. Evidently, sympatric introgression is widespread between the two parent species. The hybrids have n = 9 chromosomes as do both parents (Stebbins 1959).

Viable seeds and seedlings which resemble the many natural hybrids have been obtained by artificially pollinating emasculated flowers of bitterbrush with pollen from cliffrose (fig. 36) and the cliffrose-bitterbrush hybrid (table 1). During the 1971 season, 19 plump, obviously filled seeds were obtained by using Apache plume (*Fallugia paradoxa*) pollen on emasculated bitterbrush flowers (table 1).

Viable seed has also been obtained when bitterbrush pollen was artificially applied to emasculated flowers of Stansbury cliffrose, the cliffrose and bitterbrush hybrid, and the pistillate flowers of Apache plume (table 1).

Most antelope bitterbrush evidently is self-incompatible. This conclusion was drawn since 17 bagged branches containing unemasculated bitterbrush flowers set only four viable seeds over a 4-year period. These four seeds were all produced on the same branch in 1970. Mass pollination of bitterbrush flowers just as they begin to open is probably sufficient for hybridization since results from the bagged, emasculated controls suggest that emasculation is not necessary. Considerable time will be saved by not having to emasculate each flower. Also, pistils will mature more seed because they will not be damaged during emasculation procedures.

Antelope bitterbrush is reported to have a chromosome number of n = 9 (Thomas 1957; Stebbins 1959).

Distribution and Habitat: Antelope bitterbrush normally occurs in well-drained, sandy, gravelly, or rocky soils throughout the sagebrush, juniper-pinyon, mountainbrush, ponderosa pine, and lodgepole pine types at elevations from 60 m (200 feet) in the Pacific Northwest to 3,510 m (11,500 feet) in the Sierra Nevada Mountains (Stanton 1959; Nord 1965). In Utah, bitterbrush does occur on some clay loams where deeper rock strata furnish good drainage, and at least one form grows on a deep basic-clay loam where drainage is poor. A prostrate form grows on deep acid-clay soils in Oregon. Bitterbrush's range extends over much of temperate western America from California eastward throughout the Rocky Mountains and from British Columbia southward to Arizona and New Mexico (McMinn 1951; Stanton 1959; Hitchcock 1961).

Figure 36.--A vigorous seedling hybrid produced by pollinating emasculated flowers of a prostrate, layering antelope bitterbrush with pollen from cliffrose.

Use: Antelope bitterbrush is one of the most important browse plants in the West for game animals, sheep, and cattle. Its fall and winter protein content helps to offset protein deficiency during these seasons when herbaceous vegetation has dried up (Hormay 1943; Dietz 1972). Bitterbrush also lengthens the grazing season by providing forage 4 to 6 weeks longer in the fall than the herbs. Ferguson (1972) found that forage production can be increased considerably by topping mature plants (fig. 37). Topping can be accomplished mechanically or by grazing the stand periodically with cattle (Hormay 1943). In Utah, elk have been observed to be efficient in topping bitterbrush, particularly in periods of deep snow. This shrub is virtually unsurpassed in its ability to maintain itself under severe grazing conditions.

Antelope bitterbrush is relatively much more important and abundant in California, Idaho, Oregon, and Washington than other western States. Hitchcock and others (1961) rated *P. tridentata* as a choice ornamental for any area east of the Cascades. Layering forms are useful in stabilizing and beautifying roadcuts and other exposed sites (fig. 38). Because of its ability to grow on depleted soils and severe sites, it is an outstanding shrub for stabilizing disturbed sites.

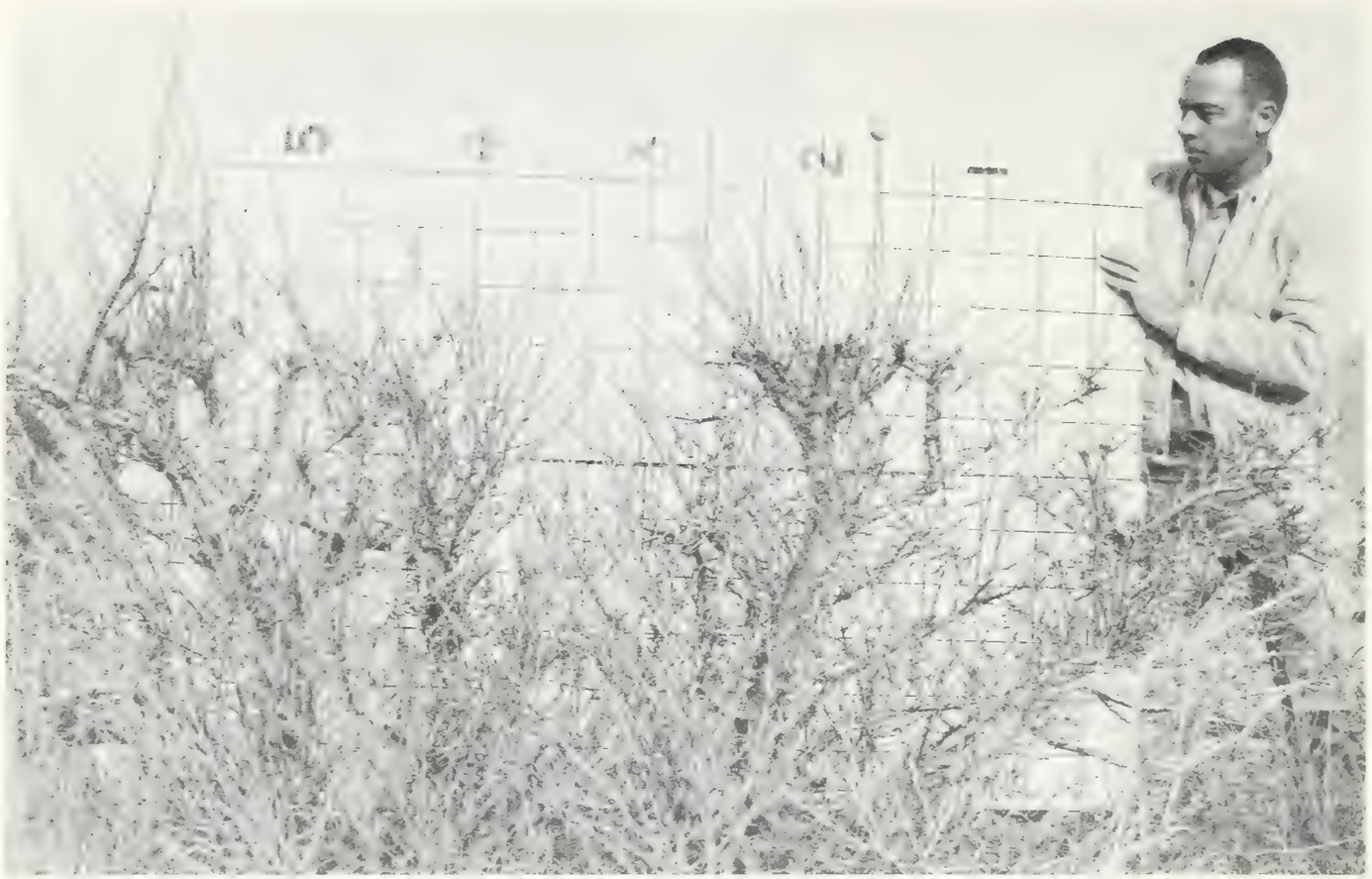

Figure 37.--Bitterbrush topped to increase production of available forage.

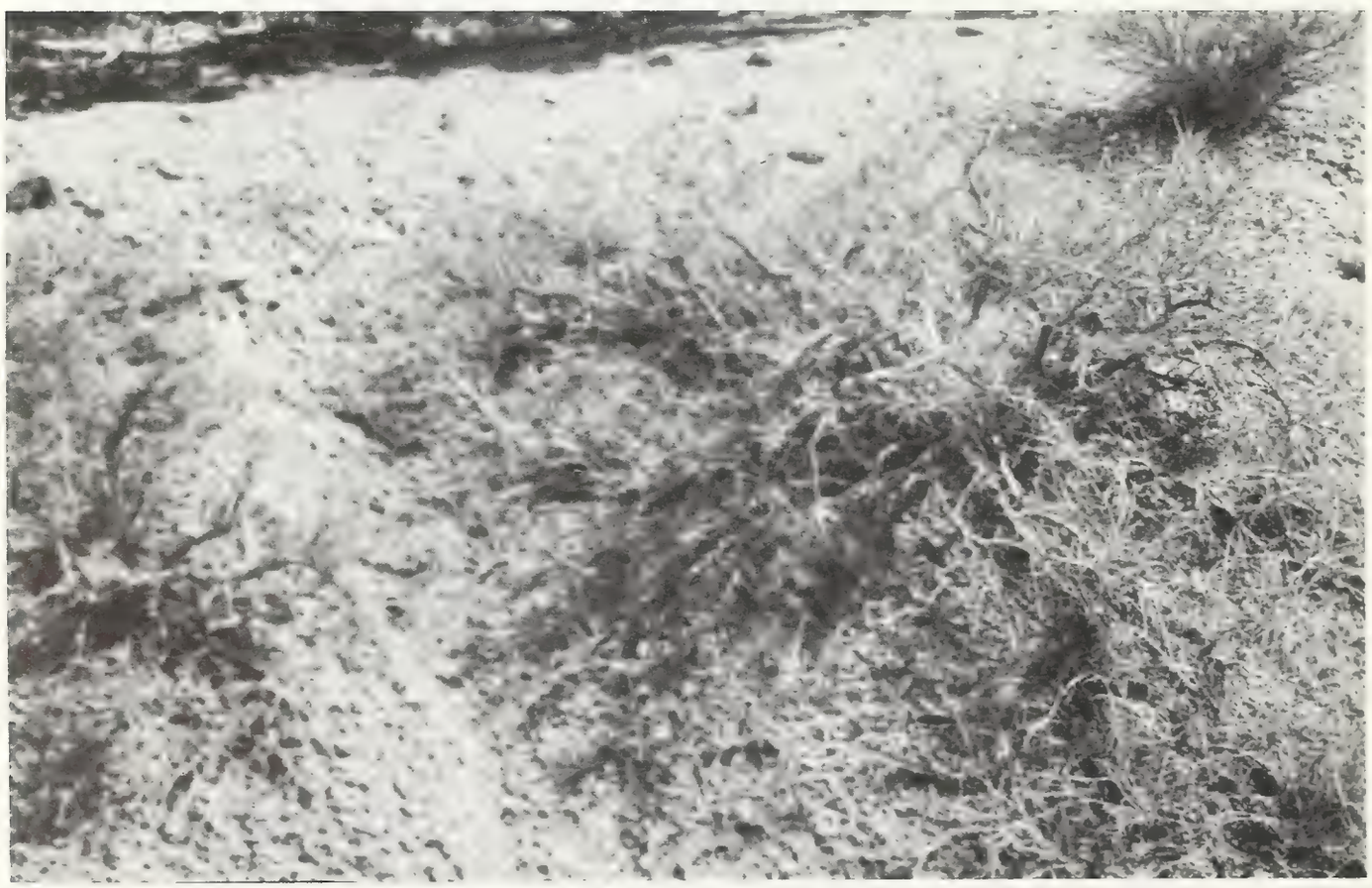

Figure 38.--Antelope bitterbrush growing on road cut in Utah County, 5 miles north of Eureka, Juab County, Utah.

Rose woodsii (Woods rose)

Woods rose is a prostrate to upright shrub from 0.5 to 3.0 m tall (fig. 39). The opposite compound leaves are composed of five to 11 leaflets which are oval, elliptic, or obovate in shape, with serrate margins. The leaflets range in size to 2.5 by 5.0 cm. Stem and branches from area to area have varying numbers of prickles. On some ecotypes, prickles are almost totally missing, whereas on others high densities are present (fig. 40).

Figure 39.--An upright woods rose. The scale is in feet.

Figure 40.--Woods rose cuttings from different accessions showing variation in prickliness. Note the hips on the cutting second from right.

Light-pink to deep-rose colored flowers are borne on lateral shoots from old wood, which are usually over 10 cm long. Flowers are rarely solitary, usually there are four or more in a corymbiform cyme. The five persistent sepals are from 1 to 2 cm long, 2 to 3.5 mm wide at base. The tip of each sepal is usually a little expanded above the median constriction. The sepals are erect or spreading in fruit. Woods rose petals are five in number and 1.0 to 2.5 cm long. Stamens and pistils are numerous. The capitate stigmas form a cluster closing the mouth of the hypanthium. Blooming occurs from late spring through midsummer, varying considerably according to elevation and exposure.

The fleshy globose to ellipsoid fruit (hip)[1] (fig. 40) is 6 to 15 mm wide and up to 2.0 cm long and contains 15 to 30 achenes. Each achene is 3 to 4 mm long with stiff hairs along one side. Wood rose averages 45,300 cleaned seeds per pound (100/g) (Plummer and others 1968).

Woods rose exhibits much variation in growth habit, number of prickles, vegetative spread, and drought tolerance. Some authorities, among them Hitchock and others (1961), recognize two varieties. Under this treatment, variety *ultramontana* is the prevalent one in the Intermountain area. Variety *woodsii* is the common woods rose on the plains and prairie east of the Rocky Mountains. Even within varieties there is substantial variation.

Hybridization: The genus *Rosa* is a natural plant assemblage. Its species, however, are often difficult to distinguish (Erlanson 1934; Harrington 1954). Many of the wild roses of western North America hybridize (Hitchcock and others 1961). Improved stock for planting purposes could be obtained by selection and breeding of the richly variable woods rose and its relatives.

The chromosome number of woods rose is $2n = 14$ (Hitchcock and others 1961).

Distribution and Habitat: Woods rose is widely distributed in western Canada and the western United States. It is found from valley floors to alpine sites, 1,070 to 3,320 m (3,500 to 11,000 feet). It is most abundant in such moist places as along stream banks, but is also found in relatively dry habitats on mountain ranges. It flourishes in moderate shade to full sunlight and so makes good growth on all aspects. Woods rose is seldom found where the average annual precipitation is less than 260 mm (12 inches).

Use: Woods rose is browsed in all seasons by livestock and big game; however, heaviest use is in the early spring and in the fall. Forms having few or no prickles are generally preferred, but a high density of prickles has a survival value, preserving plants from being too heavily grazed. Even the heavily prickled populations sometimes receive substantial use. The persistent hips provide food for birds and upland game species in the winter when little other food is available.

Some ecotypes of woods rose spread aggressively by root sprouting. These are excellent for soil stabilization. It is readily established on roadcuts and fills from both nursery stock and wildings. Results from direct seeding have been variable but, no doubt, can be improved.

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[1] Accessory fruit formed by the fleshy calyx enclosing the true fruits, the achenes.

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APPENDIX

Key to Genera and Species

1a. Ovary inferior, adnate to the hypanthium; fruit a pome.
  2a. Leaves sessile or nearly so, alternate but fascicled at the ends of the branchlets; flowers solitary or two to three together; styles two. . . *Peraphyllum ramosissimum*
  2b. Leaves petioled, not fascicled at ends of branchlets; flowers mostly several to many in a raceme; styles two to five. . . . . *Amelanchier*
    3a. Leaves mostly glabrous at maturity; petals usually more than 10 mm long; styles usually five; fruit glabrous, 10-15 mm in diameter, normally with 10 locules . . . . . *A. alnifolia*
    3b. Leaves finely pubescent; petals usually less than 10 mm long; styles two to four (rarely five); fruit frequently pubescent, 6-10 mm in diameter, with three to six locules. . . . . *A. utahensis*
1b. Ovary superior, not adnate to the hypanthium, fruit an achene.
  4a. Flowers inconspicuous; petals lacking. . . *Cercocarpus*
    5a. Leaves deciduous, flat; margins dentate . . . . . *C. montanus*
    5b. Leaves evergreen, somewhat revolute; margins entire or dentate.
      6a. Leaves, at least some, with margins dentate; a hybrid . . . . *C. montanus* X *C. ledifolius*
      6b. Leaves entire, usually strongly revolute.
        7a. Leaves elliptic, over 12 mm long; plants tall shrubs or small trees. . . . . *C. ledifolius*
        7b. Leaves linear to narrowly oblong, usually less than 12 mm long; plants low, intricately branched shrubs . . . . . *C. intricatus*
  4b. Flowers showy; petals present.
    8a. Leaves pinately compound; achenes enclosed in the fleshy calyx tube . . . . . *Rosa woodsii*
    8b. Leaves simple; achene(s) not enclosed in a fleshy calyx tube.
      9a. Bractlets present at base of flower; pistils more than 12 . . . . . *Fallugia paradoxa*
      9b. Bractlets absent; pistils less than 12.
        10a. Pistils four or more; styles becoming elongated and plumose; leaves usually with five or more lobes . . . . . *Cowania mexicana* var. *stansburiana*
        10b. Pistils less than four; style not markedly elongated or plumose; leaves usually with five or less lobes.
          11a. Pistils two to three; style slightly elongated or plumose; leaves usually with three to five lobes; a hybrid . . *Cowania mexicana* var. *stansburiana* X *Purshia tridentata*

11b. Pistils one to two; styles short and tapering to tip; not plumose; leaves usually with three lobes . . *Purshia*

12a. Leaves three-toothed, pubescent, usually deciduous; flowers about 8 mm broad. . . . *P. tridentata*

12b. Leaves three- to five-toothed, nearly hairless, dotted with impressed glands; evergreen, flowers about 20 mm broad . *P. glandulosa*

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1975. Characteristics and hybridization of important Intermountain shrubs. I. Rose family. USDA For. Serv. Res. Pap. INT-169, 35 p. (Intermountain Forest & Range Experiment Station, Ogden, Utah 84401.)

This paper reviews the state of knowledge, records observations, and presents original data for important Intermountain rosaceous shrubs. A key is given to aid recognition of taxa. Each species treated is described and its hybridization, distribution and habitat, and use are reviewed. Pioneer hybridization studies on the compatible genera Cowania (cliffrose), Fallugia (Apache plume), and Purshia (bitterbrush) are presented.

OXFORD: 181.1:165.71.
KEYWORDS: distribution, hybridization, hybrids, rosaceous shrubs, habitat, use, Amelanchier, Cercocarpus, Cowania, Fallugia, Purshia, Rosa.

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Headquarters for the Intermountain Forest and Range Experiment Station are in Ogden, Utah. Field Research Work Units are maintained in:

Boise, Idaho
Bozeman, Montana (in cooperation with Montana State University)
Logan, Utah, (in cooperation with Utah State University)
Missoula, Montana (in cooperation with University of Montana)
Moscow, Idaho (in cooperation with the University of Idaho
Provo, Utah (in cooperation with Brigham Young University)
Reno, Nevada (in cooperation with University of Nevada)


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